Performance Emulation of the Cell-based AMR Cosmology Simulation Code – ART

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Abstract. In this paper, we design an emulator for cell-based AMR (adaptive mesh refinement) cosmology simulations, in particular, the Adaptive Refinement Tree (ART) code, which is an advanced "hydro+N-body" simulation tool. Moreover, we evaluate three different load balancing schemes for cell-based cosmology simulations via the emulator. Results provide us useful insight into the performance and scalability of different load balance schemes.

In order to fully utilize the ever-growing supercomputers for high-fidelity simulations and include new physical processes, cosmologists are always making efforts to improve cosmological codes. As a result, cosmology simulation codes become increasingly complex, and improving cosmological codes is time-consuming and complicated. Without rigorous performance analysis before making major code modification, it is likely that the expected performance improvement is not achieved or performance is degraded. Thus, it is critical to provide a new approach to examine potential performance impacts with different code changes in a time-efficient way.

In this paper, we present our design of a performance emulator for cell-based AMR (adaptive mesh refinement) [1] cosmology simulations, in particular, the adaptive refinement tree (ART) code [2]. The emulator follows the flow of the original application, while the major physical computation and inter-process communication are replaced by runtime performance estimates provided by the emulator. Results show that the emulator achieves good accuracy. Moreover, we evaluate three representative load balancing schemes for cell-based cosmology simulations via the performance emulator. The use of the emulator enables us to quickly identify the issues associated with different load balancing schemes without spending months or even years in code implementation.

References

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